

Swine Species

352 Multi-breed comparison of body composition in swine using dual energy X-ray absorptiometry (DXA) and magnetic resonance imaging (MRI) under special consideration of Cerdo Iberico. A. M. Scholz*, S. Schneider, and P. V. Kremer, *Ludwig Maximilians University Munich, Oberschleissheim, Bavaria, Germany.*

Swine breeders try to meet different consumer demands worldwide. Therefore in this study, totally 77 pigs were studied by dual energy X-ray absorptiometry and magnetic resonance imaging at an average age of the breeding groups between 144 and 160 days. The pigs originated from different extensive or conventional breeds or crossbreeds: Cerdo Iberico (Ib; n=5); Duroc (Du) x Ib (DuIb, n=15); German Landrace + German Large White = White Sow Lines (WSL; n=8), Hampshire (Ha) + Pietrain (Pi) x Ha + Pi x PiHa (Pi_Ha; n=6); Pi x Du + Pi x PiDu (Pi_Du; n=24); and Pi or PiDu x WSL (n=19). A whole body scan was performed by dual energy X-ray absorptiometry with a GE Lunar DPX IQ in order to measure the amount and percentage of fat tissue, lean tissue and bone mineral, while a Siemens Magnetom Open with a large body coil was used for magnetic resonance imaging in the thorax region between 13th and 14th vertebrae in order to measure longissimus muscle and above fat areas of both body sides. A mixed model procedure using SAS 8.2 was used to analyze the data. As expected, the extensive breed Ib followed by DuIb crossbreeds shows the highest body fat content combined with the smallest loin eye areas and a lower body weight at an average age of 154 days. The least amount of fat and largest muscles deposit pigs with pure Ha or Pi x Ha origin. The (white) sow lines and their terminal crossbreeds or crossbreeds with Pi x Du origin show an intermediate body composition. The highest body weights reached DuIb and Pi_Du combined with a completely diverse body composition (DuIb = fat; Pi_Du = lean). DuIb has the significantly highest DXA bone mineral density. Therefore, with exception of Cerdo Iberico itself, DuIb seems to be strongly suited for outdoor swine farming not alone in Spain.

Table 1. DXA and MRI results

Breeding Group	DXA Fat %	DXA BMD g/cm ²	MRI Loin cm ²	MRI Fat cm ²	Body Weight kg
Ib	27.2±1.6 ^a	1.00±.02 ^{ad}	46 ±5 ^a	38 ±3 ^a	47 ±4
DuIb	25.0±1.0 ^a	1.15±.01 ^b	74 ±3 ^{b*}	41 ±2 ^a	75 ±2
WSL	16.6±1.4 ^c	1.06±.02 ^c	82 ±4 ^{b*}	25 ±3 ^b	73 ±3
Pi_Ha	12.4±1.4 ^b	1.00±.02 ^{ad#}	99 ±4 ^c	21 ±3 ^b	64 ±3
Pi_Du	15.3±0.9 ^{bc}	1.04±.01 ^{ac#}	96 ±3 ^c	23 ±2 ^b	74 ±2
Pi or PiDu x WSL	15.4±1.0 ^{bc}	0.98±.01 ^d	93 ±3 ^c	23 ±2 ^b	72 ±2

All data were corrected for an age of 154 d. LSM with different superscripts differ significantly (P<.05). °[N], # P=0.054; * P=0.072

Key Words: Swine, Body Composition, Magnetic Resonance

353 Performance and carcass characteristics of pigs destined for natural label or commodity pork markets. A. F. Harper*¹, M. J. Estienne¹, T. D. Pringle², and K. A. Alberti¹, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²University of Georgia, Athens.

Weanling pigs (n = 72) were used to assess diet and sire effects on pork produced for natural label or commodity markets. Natural label

diets contained no antimicrobial additives or animal slaughter by-products. Commodity diets contained antimicrobial additives (27 ppm carbadox followed by 33 ppm bacitracin methylene disalicylate) and animal slaughter by-products. Pigs were produced by AI of Yorkshire x Landrace sows using semen from a Berkshire boar or a terminal-line Hampshire boar. Treatments were: natural diets fed to Berkshire-sired pigs, natural diets fed to Hampshire-sired pigs, commodity diets fed to Berkshire-sired pigs and commodity diets fed to Hampshire-sired pigs. There were 6 replicate pens of 3 pigs each per treatment. Feed and water were available ad libitum. Two pigs per pen from 5 replications were selected on d 132 for harvest and carcass evaluation. During the nursery period (d 0 – 34), pigs fed the natural diet had lower ADG (431 vs. 458 ± 9 g, P = 0.06) than those fed the commodity diet; sire effects during the nursery period were not significant (P > 0.16). Thereafter there were no effects of diet or sire on performance during the growing-finishing period (d 35 – 132) or over the entire trial (P > 0.26). Carcass evaluation showed no fat or muscling differences due to diet (P > 0.15), but pigs sired by the Berkshire boar had greater tenth rib back fat thickness (27.2 vs. 21.7 ± 1.4 mm, P = 0.03) and smaller loin muscle area (41.2 vs. 54.5 ± 1.7 square cm, P = 0.001) than pigs sired by the Hampshire boar. Pigs fed the natural diet had greater loin shear force (3.04 vs. 2.56 ± 0.05 kg force, P = 0.05) than those fed the commodity diet. For pigs sired by the Berkshire boar, loin pH was greater (5.57 vs. 5.46 ± 0.03, P = 0.05) and Minolta a* (redness) value was lower (9.8 vs. 11.5 ± 0.4, P = 0.02) than in pigs sired by the Hampshire boar. No other differences in objective pork quality measures were observed (P > 0.37). For the 132 d trial pig performance was similar across feeding programs and sires. Pigs sired by the Berkshire boar produced more subcutaneous fat and less muscling, but differences in pork quality were minor.

Key Words: Pig, Diet, Sire

354 Effect of gender and slaughter age of heavy pigs on production of high quality dry-cured hams. M. A. Latorre*¹, L. Ariño², and B. Blanco³, ¹Centro de Investigación y Tecnología Agroalimentaria de Aragón, Zaragoza, Spain, ²Integraciones Porcinas S.L., Teruel, Spain, ³Jamones y Embutidos Alto Mijares S.L., Teruel, Spain.

High quality dry-cured hams under the protection and designation of “Teruel hams” trademark are produced from heavy pigs in a specific area of Spain. Two aspects are required to consider finally a carcass suitable for Teruel ham; carcass weight and fat depth at Gluteus medius (GM) level should be at least 84 kg and 18 mm, respectively. A total of 120 (Landrace x Large White) x Duroc pigs, with an average age of 176 d, were used to study the effect of gender and slaughter age on growth performance and carcass quality of pigs destined to Teruel ham. There were three treatments; barrows slaughtered at 196 d of age (B; 130.8 kg BW), gilts slaughtered at 203 d of age (G1; 130.2 kg BW), and gilts slaughtered at 210 d of age (G2; 134.3 kg BW). Each treatment was replicated four times (ten pigs penned together). Animals fed commercial wheat, barley, and soybean meal diet, containing 2,360 kcal NE/kg and 0.68% total lysine. B ate more feed (P < 0.001), grew faster (P < 0.05), and showed worse feed conversion ratio (P < 0.01) than G1 or G2. No effect of treatment on carcass weight, and therefore on proportion of carcasses with 84 kg of minimum weight, was detected (P > 0.05). However, B had more fat at GM than G1, with G2 in an intermediate position (P < 0.05). In consequence, B and G2 showed similar percent-

age of carcasses with at least 18 mm of GM fat depth and both higher than G1 ($P < 0.001$). The weight of trimmed ham was not affected by treatment ($P > 0.05$), but the trimmed ham yield was lower in B or in G2 than in G1 ($P < 0.01$). At the end of the trial, B and G2 showed similar final percentage of suitable carcasses for Teruel ham, and both higher than G1 ($P < 0.001$). It is concluded that the production of suitable Teruel ham is optimum for barrows at 130 kg BW. However, an increase in slaughter age by two weeks in gilts, with regard to barrows, improves the production and the homogeneity of Teruel ham.

Key Words: Slaughter Age, Dry-Cured Ham, Pigs

355 Genetic opportunities for pork production without castration. J. W. M. Merks*, K. A. Engelsma, S. Bloemhof, and E. F. Knol, *IPG, Institute for Pig Genetics B.V., Beuningen, The Netherlands.*

Quality of food in terms of health and taste has high priority in our society and consumers do not accept off-flavor meat. Therefore, in most countries, male pigs are castrated shortly after birth to prevent the production of meat with the so called 'boar taint'. However, castration is a surgical intervention which is of growing concern in the society and becoming an animal welfare issue. In addition pork production with entire males is 5-12% more efficient than pork production with male castrates.

The main responsible compounds for boar taint are androstenone and skatole but these substances do not explain the perception of boar taint in taste panels completely. More compounds have recently been discussed in this respect, such as indole, and other steroids of the Δ -16-steroids group.

The genetic aspects of the 3 main boar taint components, androstenone, skatole and indole were investigated in purebred animals of a commercial sire line; more than 1300 fat samples from the neck were collected of pigs with an average live weight at slaughter of 125 kg and analyzed for these 3 compounds. Average values (minimum and maximum) were for androstenone; 1.59 $\mu\text{g/g}$ (0.01 - 10.15), for skatole 0.075 $\mu\text{g/g}$ (0.01 - 0.93) and for indole 0.05 $\mu\text{g/g}$ (0.01 - 0.68).

Heritabilities for the boar taint compounds ranged between 0.25 and 0.75, among others depending on estimated before or after log transformation or as a 0/1 trait with threshold values close to what is generally seen as accepted. The genetic correlations with production traits were close to zero or favorable like with backfat and lean meat%. For female reproduction traits only androstenone showed clearly negative genetic correlations with litter mortality (-0.59), interval weaning- 2nd insemination (-0.44), and with age at first insemination (-0.24). Genetic correlations with the male reproduction traits (volume, motility, longevity of semen) were also close to zero. These results clearly indicate the genetic opportunities to lower concentrations of the main compounds of boar taint, which on long term may enable production of entire male pigs without the problems of boar taint.

Key Words: Castration, Boar Taint, Selection

356 Lignocellulose as dietary fiber source in swine nutrition. A. Kroismayr*^{4,2}, J. Leibetseder¹, C. Plitzner², K. Neufeld³, and P. Affentranger⁴, ¹University of Veterinary Medicine, Vienna, Austria, ²University of Natural Resources and Applied Life Sciences, Vienna, Austria, ³Animal Nutrition Research Center, Austria, ⁴Agromed Austria, Kramsbrunn, Austria/EU, ⁵UFA AG, Switzerland.

Lignocellulose from fresh wood containing fermentable and non-fermentable fiber components is used in animal nutrition as fiber source because of its positive impact on digestion and for prevention of diarrhea. Fermentable and non-fermentable fiber components have different modes of action in the GI tract and seem to influence digestive process positively due to symbiotic activity.

In the presented piglet study, carried out by UFA AG, Switzerland, a combination of fermentable and non-fermentable lignocellulose components was investigated. For the 35 days lasting experiment 228 weaning piglets were split into 2 groups. Control group received a standard weaning diet including organic acids and feed enzymes. Treatment group received the control diet plus 1.5 % of the investigated lignocellulose product. The treatment effects were evaluated by analysis of variance (ANOVA). Means were compared with Bonferroni - Holmes test ($p < 0.05$).

Results show positive influence of lignocellulose on performance of piglets. Daily weight gain was significantly higher in the treated group (364 g per day) compared to the control group (342 g per day). Feed conversion rate was not influenced by the lignocellulose product (1.54 treatment vs. 1.57 control). In conclusion the combination of fermentable and non-fermentable lignocellulose components led to increased performance of piglets in this trial.

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Key Words: Dietary Fiber, Lignocellulose, Piglets

357 Effects of crystalline amino acids and sodium bicarbonate on physiological pH in swine. K. L. Dorton, L. N. Edwards*, T. E. Engle, R. M. Enns, and D. B. Anderson, *Colorado State University, Fort Collins.*

This experiment was conducted to determine the effects of dietary inclusion of crystalline amino acids and NaHCO_3 on urine and blood parameters indicative of physiological pH in swine. The experiment was a crossover design study divided into 6 periods consisting of the following: P1) 4 d acclimation phase; P2) 6 d baseline phase; P3) 4 d treatment; P4) 4 d treatment crossover; P5) 2 d sodium bicarbonate (NaHCO_3) addition; and P6: 2 d NaHCO_3 crossover. Barrows ($n = 8$) were stratified by urine pH collected during P2 and by initial body weight. During P3 and P4, treatments consisted of: 1) soybean meal (high protein diet; HP) or 2) crystalline amino acids (low protein diet; CAA). During P5 and P6, treatments consisted of the above diets with and without the addition of NaHCO_3 . Diets were formulated to meet or exceed NRC (1996) requirements for energy, protein, vitamins, and minerals. During P3 and P4, barrows that received HP had a greater stored urine pH (Mean \pm SEM, HP: 7.81 ± 0.08 , CAA: 7.66 ± 0.08 ; $P = 0.02$), blood pH (HP: 7.37 ± 0.008 , CAA: 7.32 ± 0.008 ; $P < 0.01$), blood urea nitrogen (BUN; HP: 10.24 ± 0.63 , CAA: 6.94 ± 0.63 ; $P < 0.01$), and ionized Ca (iCa; HP: 1.48 ± 0.02 , CAA: 1.43 ± 0.02 ; $P = 0.02$), and lower partial pressure carbon dioxide (HP: 55.61 ± 2.44 , CAA: 65.74 ± 2.44 , $P = 0.01$) and sodium concentration (HP: 141.33 ± 0.08 , CAA: 142.08 ± 0.08 , $P < 0.01$) than barrows that received CAA. During P5 and P6, barrows that were supplemented with NaHCO_3 had a greater stored urine pH ($P < 0.01$), base excess ($P < 0.01$), bicarbonate concentration ($P = 0.04$) and total carbon dioxide ($P = 0.05$) and tended to have a greater blood pH ($P = 0.08$). Sodium bicarbonate supplementation also resulted in lower BUN ($P = 0.03$), iCa ($P = 0.01$), potassium concentration (P

= 0.02), chloride concentration ($P = 0.02$), and glucose concentration ($P = 0.02$). These results indicate that the CAA diets were acidogenic and that the addition of 2.5% NaHCO_3 reversed this acidogenesis by affecting physiological indicators of pH.

Key Words: Acid Base Balance, Acidogenic, Dietary Electrolyte Balance

358 Effects of inclusion of fermentable carbohydrates on L-tryptophan metabolism by porcine fecal microbiota studied *in vitro*. C. Y. Li*, J. X. Liu, Y. Z. Wang, Y. M. Wu, and J. K. Wang, *Ministry of Education Key Laboratory of Molecular Animal Nutrition, Zhejiang University, Hangzhou, P.R. China.*

Sugar beet pulp (SBP), rye grass hay (RYE), alfalfa hay (ALF) and fructooligosaccharides (FOS) were used to investigate their effects on the metabolism of L-tryptophan to skatole and indole by a mixed bacterial population from the large intestines of pigs. Microbial suspensions were anaerobically incubated at 38°C, and indole compounds, pH value and volatile fatty acids were analyzed after 24 h fermentation. Effects of carbohydrate sources on the microbial diversity were analyzed using denaturing gradient gel electrophoresis (DGGE) of PCR amplicons of 16S rDNA, cloning and sequencing. Skatole contents and its relative rate of production were significantly decreased by SBP or FOS addition, but increased by addition of RYE or ALF. Rate of tryptophan degradation was reduced by ALF addition remarkably. Total and individual volatile fatty acids were significantly higher in all carbohydrate-added groups than in the none-added. Additions of SBP, RYE, ALF and FOS in pig fecal slurries with L-tryptophan markedly decreased the culture medium pH values. The DGGE profiles showed differences between cultures with different carbohydrate substrates. Fermentation with SBP showed a higher bacterial diversity than with others, with three distinct bands appeared. Sequences of the corresponding 16S rRNA of two bands were related to *Eubacterium rectale* (94%) and *Clostridium sp.* (96%), respectively. Three bands were present only in SBP, RYE and ALF samples. Two of them represented 93 and 98% similarity to *Lachnospira pectinoschiza* and *Clostridium disporicum* DSM 5521, respectively. These results suggest that the reduced contents of skatole observed in the presence of SBP and FOS may be caused by decreased tryptophan degradation to indolic compounds and by shifted microbial metabolism of tryptophan toward indole production at the expense of skatole, resultant from the changed microbial ecosystem and pH value. The bacteria *Clostridium disporicum* DSM 5521 may play a role in the production of skatole.

Key Words: Carbohydrate Sources, Pig Fecal Bacteria, Skatole

359 The impacts of vaccination and feeding a gel nutritional supplement on nursery pig performance. L. Layman*¹, W. Holt¹, L. Karriker¹, K. Stalder¹, B. de Rodas², D. Brown², and A. Johnson¹, ¹Iowa State University, Ames, ²Land O'Lakes Purina Feed, Gray Summit, MO.

An experiment involving 192 weanling pigs (4.2 kg BW) was conducted to determine if feeding a nutritional gel supplement when vaccinated improved pig performance. Pigs were sorted by size and sex and penned in groups of four (12 pens/treatment) in an off-site nursery. Dietary

treatments were applied to pens in a 2x2 factorial arrangement with one factor being with and without vaccination and another factor with and without the nutritional gel supplementation. Pigs in the vaccinated groups received a commercial single dose of *Mycoplasma hyopneumoniae* killed bacterin (2 cc vaccine/pig) on day 10 post-weaning and pigs on the gel group received the nutritional supplementation in a gel form (UltraCare®Gel) on d 9 to 11. All pigs were fed common Phase 1 (d 0 to 7), 2 (d 7 to 14), 3 (d 14 to 28) and 4 (d 28 to 42) diets. Pigs provided the gel weighed more ($P = 0.048$) than non gel pigs on d 14. Pigs not vaccinated tended ($P = 0.08$) to weigh more on d 14 when compared to vaccinated pigs. From d 7 to 14, pigs receiving the nutritional supplementation in the gel form had greater ($P = 0.048$) ADG than pigs not receiving gel and vaccinated pigs had lower ($P = 0.09$) ADG than non-vaccinated pigs. Pigs provided the gel had superior ($P < 0.01$) ADFI during d 9 to 11 when compared to pigs not receiving the gel. Pigs not vaccinated had improved ($P < 0.01$) ADFI on d 10 and d 7 to 14 when compared to vaccinated counterparts. Feed to gain (F/G) from d 7 to 14 was greater ($P = 0.004$) for pigs receiving the nutritional supplementation in a gel form versus those that did not. There were no ($P = 0.98$) vaccination effects for Feed: gain. During the overall 42-d experiment, no ($P > 0.05$) differences were observed in ADG, ADFI or F/G between vaccinated and non-vaccinated pigs or between pigs fed the nutritional supplementation in a gel form and non-gel fed pigs. In conclusion, using a gel-based product at vaccination time for nursery pigs offers some short term performance benefits.

Key Words: Gel, Pigs, Vaccination

360 Integrating benefits of organic apple and pork production: Evaluation of Plum curculio larva survival with ingestion and passage through the pigs' digestive tract. D. W. Rozeboom*, D. L. Epstein, J. M. B. Moore, and M. E. Whalon, *Michigan State University, East Lansing.*

The ability of the Plum curculio larvae to survive passage through the pigs' digestive tract was tested by feeding known numbers of live larvae and examining total fecal collections in a 5-day feeding study. Plum curculio, *Conotrachelus nemophar*, is a pest management challenge faced by upper Midwest organic fruit growers. The overarching project goal was to develop a system that integrates swine grazing for control of the Plum curculio insect, while enhancing profit potential through sales of organic apples and pork. This experiment was conducted to understand the effectiveness of grazing pigs in consuming and killing the Plum curculio larvae residing in dropped apples on the orchard floor. Six barrows weighing 28.7 to 33.1 kg, were individually-housed in a 1.2 x 1.8 m pens equipped with low-pressure nipple drinkers. Flooring was perforated plastic to allow urine to pass uncollected through to concrete flooring and drains about 30 cm below. Fencing was solid plastic in order to prevent neighboring pigs from interfering with the collection of feces which was done using bags directly attached on the skin surrounding the anus. Each morning, pigs received 9 to 15 live Plum curculio larvae which had been gently mixed into 110 g of apple pulp. After consumption of the pulp-larvae mixture, pigs were given 340 g of a corn-soybean meal based diet. Two other meals of similar amounts of pulp and dry feed were provided in the afternoon and evening. Fecal bags were changed 3 times daily and feces were gently washed using flowing water, a soft spatula, and grain screens. A total of 264 Plum curculio larvae were fed in 26 meals which were followed by complete 24-h fecal collections. In 3 instances fecal bags had been detached prior to staff arrival and feces lost. No live Plum curculio larvae were found in any of the complete

fecal collections. The remains or carcass of one dead larva was found in the feces of one pig on d 2. This experiment demonstrated that ingestion by pigs was lethal to *Plum curculio* larvae.

Key Words: Pig, *Plum Curculio*, Organic

361 Effects of environment on non-ambulatory, injured and fatigued pigs and losses during transport and lairage at a commercial abattoir. R. Fitzgerald*¹, K. Stalder¹, N. Matthews², C. Schultz-Kaster², and A. Johnson¹, ¹*Iowa State University, Ames*, ²*Farmland Foods, Milan, MO*.

The objective of this retrospective study was to quantify the effects of harvest week, weather, and transport conditions that influence the frequency of non-ambulatory, injured and fatigued pigs and mortalities during transport and lairage. A total of 1,923,441 pigs were harvested at a commercial abattoir. Relative humidity, temperature, wind speed, and dew point were collected for trailer loads (n = 11,553) from of pigs May 2005 to April 2006. A temperature-humidity index was cal-

culated (NOAA,1976) and was used as a model covariate along with load time per pig, trailer density, and pig rest time. Week, pull nested within farm, split or normal load type, load crew, driver, trailer, wind direction, and wind speed were used as fixed effects in the model for the analysis of total defects (defects = fatigued + injured + dead pigs per trailer load) percentage per load using generalized linear models (GLIMMIX, SAS Inst. Inc.). The ILINK function was used to convert logarithmically-transformed trait means to their original units of measure. The frequency of fatigued, injured, and dead pigs occurred at 5.46 (n = 10510), 0.55 (n = 1061), and 2.32 (n = 4459) per thousand pigs transported, and 60.03% of the loads resulted in at least one defect. Pigs transported to the abattoir during summer months (June – August) resulted in fewer defects (P<0.001) than pigs transported during winter months (December – February) due to a higher incidence of fatigued and dead pigs. Contrarily, injured pigs increased in frequency during July through October. Percentage of defects increased (P<0.0001) with trailer density. The results of this study demonstrate that multiple factors influence and could be modified to reduce the percentage of defects per load of finishing pigs.

Key Words: Pigs, Transport, Environment